

Stebbing (Chairman), Rev. J. O. Bevan, Mr. G. J. Symons, Prof. W. W. Watts, and Mr. T. V. Holmes (Secretary).

A short report, stating that the resolution passed at the Bristol meeting of the conference of delegates on the desirability of securing the co-operation of the coastguard as observers of coast erosion had been favourably received by the Admiralty, and giving copies of the forms issued to the coastguard for the promotion of uniformity in their observations was in the hands of every delegate present, and was taken as read. Then Rev. T. R. R. Stebbing, after alluding to the result of last year's discussion on coast erosion, read a short paper on the living subterranean fauna of Great Britain and Ireland.

The first undoubted mention of an underground crustacean seemed to be that of an amphipod found in London and named by Dr. Leach, of the British Museum, in 1813. Since that time many valuable treatises on the subterranean fauna of various parts of the globe have appeared in many European languages, Polish among others. The English student might be advised to study "The Cave Fauna of North America," by Dr. Packard, published in the *Memoirs of the National Academy of Sciences*, vol. iv., Washington, 1888. Also "The Subterranean Crustacea of New Zealand," by Dr. Charles Chilton, published in the *Transactions of the Linnean Society of London*, 1894. Packard enumerated 308 European cave animals and 102 American. This list of 410 included a few Protozoa, a sponge, two hydras, a few worms, one mollusc, several crustacea and myriapods, numerous arachnids and a host of Coleoptera, the other insects being chiefly Thysanura. The vertebrates consisted of four American fish and one European batrachian, the celebrated *Proteus anguineus*. The known well fauna of Great Britain and Ireland comprised only four species which belong to the amphipoda. These, however, de Rougemont would reduce to a single species. In addition, it may be mentioned that an insect and a copepod have been found in the recesses of coalpits in Scotland and northern England. After noticing the colourlessness and blindness characteristic of subterranean fauna, Mr. Stebbing remarked, in conclusion, that it would be strange should the caverns and wells of Great Britain and Ireland not yield, on investigation, a fauna comparable in some degree to that found in other parts of the world. In this research he hoped that some members of our local scientific societies might take a share.

In answer to a question as to the best way of catching the well shrimp, Mr. Stebbing replied that a good plan was to wait till the well was nearly empty, then let down a bucket and withdraw it as quickly as possible. Sometimes well shrimps were brought up when pumping was going on.

Some discussion then arose, in which Rev. J. O. Bevan, Mr. T. Workman, Mr. Hotblack and Mr. Stebbing took part, as to whether the bats in the Mammoth Cave at Kentucky passed all their time there. The matter could not be absolutely settled, though there seemed to be a presumption against their doing so; Mr. Workman stating that he had not found them in the depths of the cave, though they were in large numbers near the mouth.

SECOND MEETING OF THE CONFERENCE, SEPTEMBER 19.

The Corresponding Societies Committee were represented by Rev. T. R. R. Stebbing (Chairman), Dr. Garson, Mr. G. J. Symons, Prof. W. W. Watts, and Mr. T. V. Holmes (Secretary).

After a long and desultory debate on the best ways of increasing the usefulness of the meetings of the Conference, during which Mr. Stebbing was obliged to leave, and Prof. W. W. Watts became Chairman, Mr. Hugh Blakiston, Secretary of the "National Trust for Places of Historic Interest or Natural Beauty," delivered an address on the aims and work of the Trust.

Section A.—Mr. G. J. Symons stated that the Committee for Seismological Observations was much in need of a home.

Section C.—The Chairman remarked that the Erratic Boulders Committee had presented a report. The Geological Photographs Committee would be glad to receive contributions of photographs. They hoped shortly to be able to publish a selection of typical photographs. Their duplicate collection of prints and slides would be sent to any local society wishing to exhibit them.

Section D.—Rev. T. R. R. Stebbing said that the Secretary of Section D recommended the study of the fauna of wells and caverns to the Corresponding Societies.

Section K.—Mr. H. Wager had to inform the delegates that the Section had appointed a committee to consider the geographical distribution of mosses.

PROGRESS OF AGRICULTURAL CHEMISTRY.¹

AN important address has been recently delivered by Prof. Maercker, of Halle, to the German Chemical Society (*Ber.* 1897, p. 464), summarising the advances which have been made in agricultural chemistry during the last twenty-five years. Prof. Maercker pointed out that the term Agricultural Chemistry meant more at the present time than the mere application of chemistry to agriculture, as shown by the fact that the agricultural chemist, in his efforts to assist the farmer, was often more concerned with the biological sciences than with chemistry; while, in addition to his purely scientific work, he was required to take account of economic questions of the day possessing special interest to agriculturists. The following account of the most important parts of the address is given under the following heads:—I. Plant-food; II. Soils and Manures; III. Artificial Selection. It is reproduced here by the kind permission of the editor of the *Imperial Institute Journal*.

I. PLANT-FOOD.

In supplying nourishment to plants we must know what substances are necessary, and in what form and quantity they should be provided. Little progress was made in our knowledge of the subject till the quite recent introduction of the method of water-cultures of Sachs, Knoop, and Nobbe and the method of sand-cultures of Hellriegel permitted of the conduct of experiments in pure media, and thus rendered it possible to ascertain not only what substances are essential for plant-life, but also the part played by each substance in the plant cell. Thus we know now that phosphoric acid is essential for the formation of nitrogenous substances in the plant, because the albumens, which are of fundamental importance in the transformations of substances in plants, result from an intermediate phosphoric acid compound, as is indicated by the regular occurrence of lecythin in protoplasm. Again, iron is an essential constituent of chlorophyll and sulphur of albumen, and hence must be supplied to plants. The true function of calcium was for long doubtful; its action is now known to be of a medicinal character, since it serves to neutralise the poisonous oxalic acid, which is always an intermediate product of the oxidation of the carbohydrates. It was formerly thought that calcium fulfilled some important function in the leaves, being chiefly found in the foliage of plants. Since, however, the leaves are also the chief seat of the oxalic acid, this distribution of the calcium is easily explained.

The part played by potassium has only within the last three years been explained by Hellriegel, who, by exact experiments with beet-root showed that the amount of sugar in the beet stands in close relation to the amount of potassium provided for the plant. P. Wagner has made the interesting observation that the potassium may be partly replaced by sodium.

The exact value of magnesium to plants is not yet well understood, but it appears to be of importance in the formation of the nitrogenous substances of seeds, as in these considerable quantities of magnesium phosphate occur.

Nitrogen is an indispensable plant-food, for it is an essential constituent of albumen.

In addition to the quantities of mineral substances required by plants to enable them to exhibit a healthy growth, further quantities are found to be essential to satisfy what has been termed, though not very aptly, the "*mineral-hunger*" of the plant. This is best explained by an example. E. Wolff found that for the production of 100 parts of oat-plant (dried), 5 parts of phosphoric acid were necessary, when the remaining mineral substances were supplied in excess to the plant. By other similar experiments he showed that the following quantities of mineral substances were necessary for the production of 100 parts of oat-plant:—

Phosphoric acid	...	...	...	50 parts
Potash	...	...	...	80 "
Lime	...	...	...	25 "
Magnesia	...	...	...	20 "
Sulphuric acid	...	...	...	20 "

195 parts.

A total of 195 parts of mineral substances is therefore necessary in the case of the oat-plant. However, there is no oat-plant in nature which contains so little as 195 per cent.

¹ Reprinted from the *Kew Bulletin* (No. 144).

The minimum is 3 per cent. The difference, 1.05 per cent., is the measure of the "mineral-hunger" of the plant, and represents the mineral substance which does not perform any special function. This excess of mineral substance may be supplied in the form of some indifferent substance, such as silica. The observation is of considerable interest to the farmer, for it shows that it is not economical to manure crops with pure substances.

II. SOILS AND MANURES.

Having ascertained in general what substances are necessary as plant-food, the agricultural chemist has next to apply this general information to the manuring of soils which are more or less deficient in certain ingredients. It has been found, unfortunately, that the chemical analysis of a soil is of little use as a guide unless accompanied by what may be termed a "mechanical analysis," by which is meant chiefly a determination of the amount of finely-divided constituents present in the soil. It is only the finely-divided earth which presents a sufficiently large surface for the exercise of the solvent action of the water and its dissolved carbonic acid. There is one case, however, in which chemical analysis alone is of the greatest importance, viz. when only traces of some necessary element are present in a soil. Here there is no question of the need for a manure containing this substance.

If, on the other hand, large quantities of an element are present, it does not follow that there is a sufficiency in the soil even when the latter is in a satisfactory state of division, for the substance in question may be present in an insoluble or refractory form. This is commonly the case with nitrogen, which exists in the soil chiefly in the form of a mixture of indefinite nitrogenous substances known as *humus*, or mould. These substances sometimes easily give up their nitrogen to plants, but in other cases are very refractory. The uncertainty as to their action is indeed so great that certain peaty soils are known which consist almost entirely of humus, but contain, nevertheless, an insufficiency of available nitrogen.

Phosphoric acid affords another illustration. The soluble phosphoric acid of the manure is absorbed by the soil as dicalcic phosphate, which is comparatively easily soluble in the soil-water. With time, however, it may change in the soil to the insoluble tricalcium phosphate, or even to iron or aluminium phosphates, which are still less soluble.

In the case of calcium, chemical analysis has been found to be of considerable service in determining what manuring is required, since calcium is chiefly valuable in the form of carbonate or humate, and these are easily estimated in the soil.

Since then the direct method of soil-analysis is an insufficient guide to manuring, it is fortunate that chemists have been able to develop successfully an indirect method. This is the *cultivation method*, by which plants are allowed to grow in the soil under examination, after taking care to provide a sufficiency of all plant-food stuffs except the one, e.g. phosphoric acid, whose presence in available form is being tested. The plants are then analysed, and the results compared with the analyses of the same plants grown on soils provided with all the necessary plant-food stuffs. As an important result of the method it has been found that different plants take up very different quantities of the same mineral substances. On this is largely based the system of rotation of crops, where the second crop is so chosen that it chiefly removes the ingredients of the soil which have been left by the preceding crop.

With the aid of the cultivation method it has also been possible to draw up the following table, which represents the relative values of the different nitrogen compounds for plant-food.

Nitrogen of Saltpetre	...	...	...	100
" " Ammonia	...	...	...	85-90
" " Albumen	...	...	...	60

This table may be made use of in determining the nitrogen value of a manure.

The cultivation method may be used for testing the value of manures of all kinds. Thus it was by a few cultivation experiments that Wagner in Darmstadt first showed the very great value for agricultural purposes of the "Thomas" Slag, produced as a bye-product in the manufacture of iron by the basic process of Thomas Gilchrist. The million tons of phosphate meal annually produced in Germany is now wholly utilised by

the agriculturist, and its preparation for the farmer has become an important offshoot of the iron industry.

Similarly the demonstration by the cultivation method of the value of potash salts in manures has given an enormous impetus to the potash industry.

Speaking generally, the method gives us complete control over the fertility of a soil in so far as this depends on manuring. One consequence of this has been that our views as to the value of agricultural land have completely changed, for whereas formerly sandy soils were generally considered poor, they are now, by means of a system of intelligently directed manuring, made to give yields which are scarcely inferior to those of the best soils. The beet-sugar industry, which formerly could only be conducted in the best soils, has now been extended with marked success to sandy soils.

III. ARTIFICIAL SELECTION.

It might seem that with a perfect knowledge of the manuring of plants, the need for further investigation would cease, for when we have learned exactly what each plant requires to attain its highest development, we have reached a certain limit. The supply of excessive nourishment is a disadvantage, and only tends to produce sick plants.

There still remains, however, a method by which the fertility of plants may be increased far beyond the limit which nature appears to have fixed. This is the method of artificial selection which has been applied in Germany on the most approved scientific principles. German agriculture would have long since broken down under the stress of foreign competition had it not been for the perfect technology of its agriculturists. As an example the sugar-beet may be quoted. This plant contained originally but a small amount of sugar, and could only be used as a source of sugar when the price of the latter was very high. With the fall in price came the urgent need for increasing the percentage of sugar in the beet-root. This was effected by utilising the fact that sugar-richness is hereditary, so that by selecting artificially the roots richest in sugar, getting seed from these, planting the seed, again selecting the richest roots, and so on, a race of plants is at length obtained in which a high percentage of sugar is normal.¹ Accordingly the producers of beet-root seed in Germany have erected great laboratories in which the percentage of sugar in the roots is carefully determined. By applying the principle of artificial selection with regard also to the form and size of leaf and the purity of the sap, it has been found possible to improve the roots from year to year, so that now beet-sugar can easily hold its own against cane-sugar, and is indeed cheaper than flour, costing as it does in Germany less than a penny a pound.

Similar success has attended the efforts to increase the crops of different kinds of grain. The improvement in malt-barley has been specially marked.

It has been found that plants which have been highly cultivated by artificial selection easily lose their acquired characters when they are exposed to unfavourable conditions of cultivation; and this has led to many exact investigations, conducted for the most part in Germany, during the last ten years, on the chemistry of plants. The most interesting of these trace the chemical history of nitrogen as it passes from the atmosphere to the soil, then into the substance of plants, and finally back into the atmosphere.

The corresponding cycle for carbon has long been known.

Most plants assimilate nitrogen only in the form of compounds. As, however, the total quantity of nitrogen compounds in the atmosphere is comparatively small, there must be some other source of nitrogen for plants. Now the classical researches of Hellriegel have shown that there is one class of plants, the *Leguminosae*, or nitrogen collectors, which are able to assimilate elementary nitrogen and so to leave a soil in which they have been grown richer in nitrogen compounds. It has been found that the power of acting as nitrogen collectors is always associated with the presence of micro-organisms on the roots, and that the assimilation of the nitrogen is in some way not understood due to the micro-organisms. The recognition of the power of leguminous plants to act as nitrogen collectors is manifestly of great practical importance, for it shows clearly that the best rotation of crops is one in which a leguminous crop is followed by one of nitrogen consumers, i.e. plants which cannot assimilate nitrogen directly.

¹ See *Kew Bulletin*, 1897, pp. 317, 318.

Leguminous plants, whether first used as fodder for animals or simply left to decay in the soil, have their albumen changed in the first instance to amides, which under the influence of ammonia-ferments are decomposed with formation of ammonium-carbonate. The saltpetre bacillus then converts the ammonium-carbonate (and probably also amides) into saltpetre, *i.e.* into the best form of nitrogen plant-food.

Unfortunately the whole of the nitrate thus formed is never available for plants, on account of the destructive action of the nitrate-destroying bacilli, which decompose the nitrates with evolution of free nitrogen, and so complete the nitrogen cycle.

The nitrate destroyers are usually present in stable-manure, and cause a deplorable loss to agriculture, amounting in Germany to a sum of several million pounds annually.

Efforts which, as Prof. Maercker assured the German Chemical Society, are likely to meet with success at an early date, are being made to avoid this loss; and for this purpose special bacteriological investigations are now being conducted at many agricultural stations in Germany.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. Langley, F.R.S., has been appointed Chairman of the Examiners for the Natural Sciences Tripos.

Mr. E. A. N. Arber, of Trinity, has been appointed Demonstrator in Palæobotany.

Mr. W. F. Cooper, of Clare, has been nominated to the occupation of the University table in the Naples Zoological Station.

Mr. H. H. W. Pearson, of Gonville and Caius, and Mr. J. Barcroft, Fellow of King's, have been awarded the Walsingham medals for research in botany and in physiology, respectively.

The degree of Master of Surgery was on November 23 conferred on Mr. Timothy Holmes for his distinguished contributions to the art and science of surgery.

Sir Ernest Clarke has been re-appointed Gilbey Lecturer in Agricultural History and Economics for the ensuing year.

Prof. Woodhead, and Drs. Anningson, Collingridge, Notter, and Stevenson, have been appointed Examiners in State Medicine.

Dr. Somerville, Professor of Agriculture, has been elected a Fellow of King's College.

THE Lawrence Scientific School of Harvard University has received a gift of twenty thousand dollars to be used to equip the mining and metallurgical laboratories.

DR. PAUL STAECKEL, assistant professor of mathematics at Kiel, has been appointed professor ordinarius. Dr. J. Traube, privatdocent in physical chemistry at the Berlin Technical High School, has been appointed professor.

THE new leather industries buildings in connection with the Yorkshire College, Leeds, which have been erected by the Skinners' Company of London at a cost of 5000*l.*, were opened on Monday by the Master of the Guild, Mr. J. Colman. In addition to the gift of the buildings the Company has granted an endowment of 250*l.* a year for ten years, thus placing the instruction in the branches connected with the leather industry on a solid foundation.

THE Canadian *Educational Review* announces that Sir W. C. McDonald, of Montreal, whose magnificent gifts to McGill University have made him justly celebrated as a public benefactor to education in Canada, has placed in the hands of Prof. Robertson, Dominion Agricultural Commissioner, sufficient funds to establish for three years technical schools in various centres throughout the Dominion. The nature of the plan is to take one city or town in each province in which to establish regular classes in some of the ordinary schools on one or two days a week, in which scholars between nine and thirteen years of age shall spend a portion of the day in actual work with tools. This will be supplemented whenever desired by more advanced and special evening classes in manual training and technical instruction.

A COPY of the *Magnet*, the magazine of University College, Bristol, has been received. There are several noteworthy articles and items of information in the magazine, not the least

interesting being the editorial note on the appointment of Dr. Ryan, professor of engineering, to the principalship of the Woolwich Polytechnic. Dr. Ryan has been at the College for fourteen years, and has devoted his best energies to bringing the engineering department to its present satisfactory position. He would have done much more if the funds at his disposal had permitted him to develop the work of the department; but, unfortunately, the College possesses only a small endowment, and Bristol manufacturers are not so actively interested in the progress of their University College as are many commercial men in Liverpool, Birmingham, and other cities. Leaving this point, attention may be called to an article in the *Magnet* on life in a mediæval university, by Dr. Hastings Rashdall. The description of the ceremonies through which the freshman or bejannus of the middle ages had to pass before he could call himself a student of the university would suggest many comparisons to an ethnologist. It must be remarked that the periodical does not show the signs of active interest in scientific work which are given in the form of notes and articles in some other magazines of the same type.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, November 24.—Prof. G. Carey Foster, F.R.S., Vice-President, in the chair.—A paper on the conductivities of certain heterogeneous media for a steady flux having a potential was read by Dr. C. H. Lees. Two formulæ have already been proposed to express the conductivity of a mixture in terms of the conductivities of its constituents. In the first formula the conductivity is represented as the sum of a number of terms, each one of which is the product of the conductivity of any constituent and the fractional part of the mixture which is made up of that constituent. In the second formula the resistivity of a mixture is expressed in the same way with respect to the resistivities and percentages of its constituents. In general, the first of these suppositions gives results which are above the experimental values, while the second gives results which are below. If we suppose that the mixture is made up of a series of columns of the separate parts stretching normally between two equipotential surfaces, then the conductivity would be accurately represented by the first formula. If, however, we assume that the constituents are arranged in parallel layers, then the second formula would apply. In the present paper the author has attacked the problem two-dimensionally, and has investigated the relation which holds between the conductivities, when the constituents are arranged in the mixture alternately like the squares on a draughts board. Dealing first with two components it is easily shown that the problem reduces itself to finding the form of the equipotential curves and of the stream lines in a square which is divided by a diagonal into two parts of different material. By means of conformal representation Dr. Lees has referred the square under consideration to a kite-shaped quadrilateral with two opposite angles right angles, and the other two so determined by the conductivities of the constituents as to give straight equipotential lines in the two portions of the figure which represent the two materials and which are separated the one from the other by the axis of symmetry. The general relation which exists between the vector co-ordinates in the two systems has been proved by Love to consist of elliptic functions; but near the angular points of the figures a close approximation can be obtained by the use of a simple exponential expression. Taking the known solution to the problem in the case of the kite-shaped quadrilateral, it is easy to calculate the result for the square under consideration. This leads to the conclusion that the conductivity of the square is the geometric mean of the conductivities of the constituents. Allowing the medium to become fine-grained and introducing new materials, it follows at once that the logarithm of the conductivity of a mixture is equal to the sum of a number of terms, each one of which is the product of the logarithm of the conductivity of any constituent and the fractional part of the mixture which is made up of that constituent. By a superposition of fluxes, the author has shown that the above law holds for flows in four directions, and he therefore considers that with the assumed structure the formula represents the conductivity for any flux.—Dr. Lees then read a second paper on the thermal conductivities of mixtures and their constituents.